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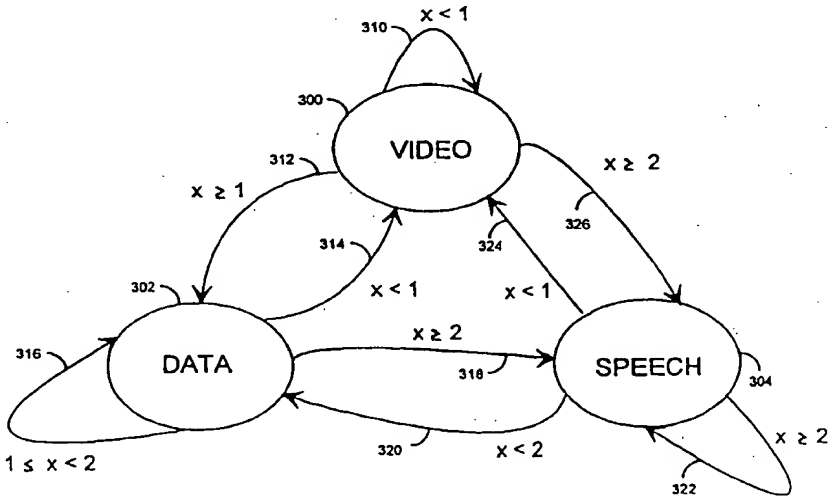

(57) Abstract

The invention relates to a method of determining the grade of service and a mobile telephone system. The method comprises assigning each user (140–146) a service class according to the grade of service guaranteed by the mobile telephone system (100) to a user (140–146) of a mobile station (120–126) on the basis of the conditions of the mobile telephone system (100). If the conditions of the mobile telephone system (100) allow several different service classes, the user (140–146) selects the service class that is the most economical and suitable for him. The mobile station (120–126) is arranged to provide the users (140–146) with the possibility of selecting the service class. The mobile station (120–126) is also arranged to receive the grade of service from the network part (110) and to indicate it to the user (140–146) in a clear form.

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International application No.
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B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 9610875 A1 (MOTOROLA INC.), 11 April 1996 (11.04.96), page 7, line 11 - line 32; page 12, line 32 - line 35	1-7,18-23
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X	US 5497504 A (ANTHONY S. ACAMPORA ET AL), 5 March 1996 (05.03.96), column 9, line 7 - line 50, abstract	1-8,18-23
A	--	9-17

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	US 5442625 A (RICHARD D. GITLIN ET AL), 15 August 1995 (15.08.95), column 1, line 45 - line 59; column 4, line 67 - line 68; column 6, line 51 - column 7, line 8 -- --------	1-23

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Information on patent family members

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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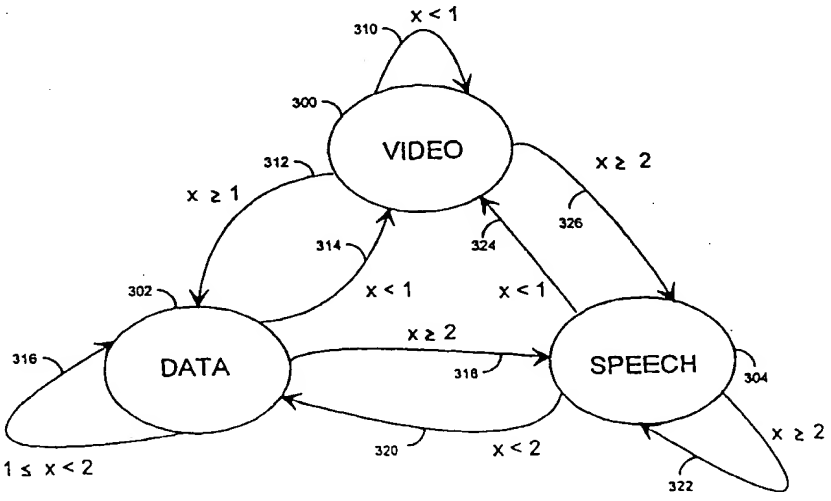
(54) Title: DETERMINING GRADE OF SERVICE AND MOBILE TELEPHONE SYSTEM



(57) Abstract

The invention relates to a method of determining the grade of service and a mobile telephone system. The method comprises assigning each user (140–146) a service class according to the grade of service guaranteed by the mobile telephone system (100) to a user (140–146) of a mobile station (120–126) on the basis of the conditions of the mobile telephone system (100). If the conditions of the mobile telephone system (100) allow several different service classes, the user (140–146) selects the service class that is the most economical and suitable for him. The mobile station (120–126) is arranged to provide the users (140–146) with the possibility of selecting the service class. The mobile station (120–126) is also arranged to receive the grade of service from the network part (110) and to indicate it to the user (140–146) in a clear form.

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DETERMINING GRADE OF SERVICE AND MOBILE TELEPHONE SYSTEM

FIELD OF THE INVENTION

The invention relates to a method of determining the grade of service provided for a user of a mobile station by a mobile telephone system, comprising a network part, mobile station and bidirectional radio link between the network part and mobile station, and said grade of service comprising service classes.

BACKGROUND OF THE INVENTION

In mobile telephone systems of the prior art the user employs a mobile station in order to transmit speech or data over a radio link. The network part does not in any way optimize the capacity use of the transmission connections it utilizes depending on whether the radio link is used for speech or data transmission. In principle, the same grade of service is provided for all users. This results in waste of capacity in the network part. Furthermore, with the present mobile telephone systems it is not possible to price services differently according to the used grade of service.

With respect to further development of the present GSM/DCS 1800 system and the UMTS system under development as well as with respect to other future mobile telephone systems it is essential that in addition to speech and data, data requiring a greater transmission capacity, e.g. moving video pictures, can also be transmitted in them. Such an advanced mobile telephone system cannot be constructed according to the principles of the present systems, i.e. so as to provide all users with the same grade of service. This would be very expensive, since the transmission capacity of the network part would have to be defined according to the service requiring the greatest amount of transmission capacity, e.g. according to the capacity required for transmitting moving video pictures.

Advanced mobile telephone systems require introduction of different methods which enable efficient and optimal use of the transmission capacity in each specific case. It must be possible to optimize the methods, and they also have to be cost-effective and provide network operators with flexibility for managing different load situations of the network part.

BRIEF DESCRIPTION OF THE INVENTION

The object of the present invention is to eliminate the drawbacks of the prior art solutions.

This is achieved with the method set forth in the introduction, characterized in that each user is assigned a service class according to the grade of service guaranteed by the mobile telephone system to a user of a mobile station on the basis of the conditions of the mobile telephone system.

The invention also relates to a mobile telephone system comprising a network part, mobile station and bidirectional radio link between the network part and mobile station, the grade of service comprising service classes, characterized in that each user is assigned a service class according to the grade of service guaranteed by the mobile telephone system to a user of a mobile station on the basis of the conditions of the mobile telephone system, and in that the network part is arranged to carry out the processing of parameters that is needed for determining the grade of service, said parameters being preselected variables representing features of the mobile telephone system and its use.

The invention further relates to a mobile telephone system comprising a network part, mobile station and bidirectional radio link between the network part and mobile station, the grade of service comprising service classes, characterized in that each user is assigned a service class according to the grade of service guaranteed by the mobile telephone system to a user of a mobile station on the basis of the conditions of the mobile telephone system, and in that the mobile station is arranged to receive the grade of service from the network part.

The method of the invention has several advantages. One of the greatest advantages is that the use of the network part is optimized according to the service class employed by the user. As a result of this, it is possible to save on costs considerably in the construction of the network part, since it is not necessary to reserve extra capacity, but the amount of capacity can be defined according to the real use. To a mobile station user the invention means increase in the quality of services, e.g. call set-up is more reliable than in the prior art. It is also possible to provide new services, e.g. transmission of moving video pictures, for the user cost-effectively, even economically. On the other hand, the user is charged on the basis of the service class he employs, whereby the user, if he so desires, can select the service class that is most

suitable and economical for him. The service class employed by the user is clearly indicated by his mobile station. The user also receives other useful information on the service class in use, e.g. the transmission speed. By utilizing the present method the network operator can flexibly control the use of the network part so as to optimize the costs arising from its use and the quality of the services provided for the user.

BRIEF DESCRIPTION OF THE DRAWINGS

In the following, the invention will be described in greater detail with reference to examples illustrated in the accompanying drawings, in which

Figure 1 generally shows a mobile telephone system and its users,

Figure 2 shows the essential parts of the mobile telephone system in greater detail,

Figure 3 shows a state transition chart according to the invention by way of example,

Figure 4 shows the essential parts of a base station controller,

Figure 5 shows the essential parts of a mobile station.

DETAILED DESCRIPTION OF THE INVENTION

Figure 1 generally shows a mobile telephone system of the invention. The mobile telephone system 100 comprises a network part 110, mobile station 120-126 and bidirectional radio link 130-136 between the network part 100 and mobile station 120-126.

According to the invention, the grade of service is divided into service classes according to the grade of service guaranteed by the mobile telephone system 100 to a user 140-146 of a mobile station 120-126 on the basis of the conditions of the mobile telephone system 100. The service classes comprise e.g. speech, data transmission, high-rate data transmission and video. As parameters the method employs preselected variables representing features of the mobile telephone system 100 and its use.

If the conditions of the mobile telephone system 100 allow several different service classes, the user 140-146 selects the one which is the most economical and suitable for him.

The transmission capacity available per a user 140-146 of a mobile station 120-126 functions as the determining variable in a service class. The use of the network part is optimized in such a way that the transmission

method employed in the bidirectional radio link 130-136 changes according to the features of a service class.

Another way of optimizing the use of the network part is to check how much transmission capacity the network part 110 has available when a new user 146 tries to establish a new bidirectional radio link 136 between a new mobile station 126 and the network part 110. If the amount of available transmission capacity is sufficient, the new user 146 will be assigned a bidirectional radio link 136 according to his service class. If the amount of available transmission capacity is insufficient, it will be checked whether one of the users 140-144 is underutilizing his service class, i.e. does not use the entire transmission capacity available to him. If that is the case, the service class of the user 140-144 in question will be lowered, i.e. the service class is changed to correspond to the transmission capacity utilized by the user 140-144 in question. This allows part of transmission capacity to be released. The release of transmission capacity is repeated with as many users 140-144 as necessary and possible in order to release a sufficient amount of transmission capacity for the new user 146. If it is possible to release a sufficient amount of transmission capacity, the new user 146 will be assigned a bidirectional radio link 136 according to his service class. If a sufficient amount of transmission capacity cannot be released, then the total transmission capacity of the network part 110 is in use, and the new user 146 will not be assigned a bidirectional radio link 136.

Figure 2 shows the structure of the network part in greater detail. The network part 110 comprises at least one network management system 250, at least one network system 210 and at least one base station system 220. The network management system 250 is utilized for using, controlling and maintaining different functions of the mobile telephone system. The network operator receives information on the quality of functions and services provided through the network management system 250. The network management system comprises at least one operation and maintenance centre 280. The network operator adjusts different parameters of the mobile telephone system through the operation and maintenance centre 280, thus controlling its operation. The main task of the network system 210 is call control; therefore it comprises a mobile switching centre 270. The base station system 220 is responsible for controlling the radio path and comprises at least one base station controller 230 and at least one base station 240. The base station 240

has a coverage area, i.e. cell 242. The parameters of the method are the velocity of the mobile station 120 with respect to the base station 240, the distance of the mobile station 120 from the base station 240, the load of the mobile telephone system 100 and the cell 242 type of the base station 240 providing the bidirectional radio link 130.

The parameter of velocity is examined as the absolute velocity, the parameter of distance in proportion to the cell size of the base station 240, the parameter of load in proportion to the total capacity of the cell 242 and the parameter of cell type by utilizing existing hierarchical structures.

The efficiency of calculation can be increased in such a manner that each parameter has only a small number of different values, e.g. three. On the other hand, if the grade of service is to be determined accurately, each parameter is given a sliding value from the minimum to the maximum. If the efficiency and accuracy of calculation are to be optimized, some parameters have only a small number of different values, e.g. three, whereas other parameters are given a sliding value from the minimum to the maximum.

Each service class is represented by a different state in a state machine, in which transitions from one state to another are defined by calculation of parameters. The weighted average of the parameters is calculated, and it is checked which transition condition is fulfilled at any given time. The administrator 260 of the network part 110 of the mobile telephone system 100, i.e. a person belonging to the operating personnel of the network operator, determines the weighting coefficients used in the calculation for the parameters by means of the network management system 250, whereby different parameters have different significance when the service class is determined. In that case change of even a single parameter causes change of the service class. This makes the optimization of the use of the network part 110 easier, since there can be different combinations of weighting coefficients for different situations, such methods are known as adaptive methods.

Figure 3 illustrates, by way of example, a state transition chart according to the method. The states of the state machine are, for example, video 300, data 302 and speech 304. Two inequalities are deduced from the state transition chart, $1/4(a1V + a2R + a3L + a4C)>1$ and $1/4(b1V + b2R + b3L + b4C)>2$. Three different classes, 0, 1 and 2, are determined for each parameter, velocity V, distance R, load L and cell type C. Parameters a1-a4 and b1-b4 are weighted coefficients which can be freely defined by the

network administrator. It is assumed that at the beginning the state is optimal, i.e. the video state 300. The inequalities are solved at regular intervals or for some specific reason. If the result is less than one 310, the same state remains. If the result is more than or equal to one 312, transition takes place to a worse data state 302, in which it is no longer possible to provide transmission services of video pictures for users. If the result is more than or equal to two, transition takes place directly to the worst state, i.e. conversation state 304, in which only transmission of speech is possible. The inequalities will be solved similarly in the data state 302. If the result is less than one 314, transmission takes place to the video state. If the result is more than or equal to one but less than two 316, the data state remains. If the result is more than or equal to two 318, transition takes place to the conversation state. The inequalities will be solved similarly in the conversation state 304. If the result is less than two 320, transition takes place to the data state. If the result is more than or equal to two 322, the conversation state remains. If the result is less than one 324, transition takes place to the video state.

The network part 110 is arranged to carry out the processing of parameters that is needed for determining the grade of service. For example, the base station controller 230 in the network system 210 is arranged to perform the functions according to the method. Figure 4 shows a simplified structure of the base station controller 230. The base station controller 230 comprises a group switching field 410, transcoder 420 and control unit 430. The group switching field 410 is used for switching speech and data and for connecting signalling circuits. The transcoder 420 converts different digital speech coding forms used between the public switched telephone network and mobile telephone network so as to make them compatible. The control unit 430 carries out call control, mobility management, collection of statistics and signalling (Air Interface Signalling and A Interface Signalling). The simplest way of implementing the invention is to provide the control unit 430 with software which in addition to its standard operations can determine the service class for each radio link 130-136 according to the method and signal the service class in question to the mobile station 120-126 via the base station 240. The above-mentioned functions can be realized e.g. with a general or signal processor or with separate logic. The mobile switching centre 270 or the base station 240 can also be arranged to perform the functions of the method. It will be obvious to one skilled in the art how the devices in question are to be

arranged to use the method of the invention. It will also be obvious to him that other elements of the network part 110 not mentioned herein can also be arranged to perform the functions of the method.

The mobile station 120-126 is arranged to receive the grade of service from the network part 110. Figure 5 shows a simplified structure of the mobile station. The mobile station comprises a user part 500, radio part 520 and antenna 570. The user part 500 functions as the user interface of the mobile station for the user 140-146. The radio part 520 converts the signal to be transmitted into a form suitable for the radio link 130-136 and the received signal into a form understandable to the user 140-146. The antenna 570 receives a signal from the radio link 130-136 and sends a signal to the radio link 130-136. The user part 500 comprises a speaker 502, display 504, keyboard 506 and microphone 508. The radio part 520 comprises a receiver 530, transmitter 540, control unit 550 and duplex filter 560. The receiver 530 comprises a demodulator 532, channel decoder 534, decrypter 536 and source decoder 538. The transmitter comprises a source coder 542, encrypter 544, channel coder 546 and modulator 548. The signal is received by the antenna 570, from which it continues to the receiver 530 through the duplex filter 560. First, the signal is demodulated in the demodulator 534. Then it is decoded in the channel decoder 534. Next, the decryption is performed in the decrypter 536. Finally, the received information is converted into an presentable form in the source decoder 538, after which the speech information is transmitted to the speaker 502 and the signalling transmitted from the base station is processed in the control unit 550. When the information to be transmitted reaches the transmitter 540 from the microphone 508 and control unit 550, the speech information is digitized and code words are generated from the digitized speech information and signalling in the source coder 542, after which encryption is carried out in the encrypter 544. Then the information to be transmitted is coded in the channel coder 546, after which it is modulated in the modulator 548. Finally, the information to be transmitted is supplied through the duplex filter 560 to the antenna 570. The essential idea of the invention is that the control unit 550 controls those units with which it has a connection in the figure. The simplest way of implementing the invention is to provide the control unit 550 with software which in addition to its standard operations is capable of interpreting signalling received from the base station via the source decoder 538. The mobile station 120-126 is

arranged to indicate the grade of service to the user 140-146 in a clear form. Thus the service class is indicated to the user in an understandable form, e.g. as a text, picture, tone or in some other manner known from the prior art. At its simplest the control unit 550 has software which controls the display 504 to indicate the grade of service in a clear form. In addition to the service class, the user also receives more specific information on the grade of service, e.g. the transmission speed, transmission method, error correction method, charging related to the service class or other information concerning the use. The mobile station 120-126 is arranged to provide the user 140-146 with the possibility of selecting the grade of service that is the most economical and suitable for him. At its simplest the control unit 550 has software which receives the grade of service selected by the user 140-146 by means of his keyboard 506. The functions described above can be implemented e.g. with general or signal processors or with separate logic.

Although the invention has been described above by means of an example illustrated in the accompanying drawings, it will be obvious that the invention is not limited to it, but may be modified in several ways within the inventive concept disclosed in the appended claims.

CLAIMS

1. A method of determining the grade of service provided for a user (140-146) of a mobile station (120-126) by a mobile telephone system (100), comprising a network part (110), mobile station (120-126) and bidirectional radio link (130-136) between the network part (100) and mobile station (120-126), said grade of service comprising service classes, **characterized** in that each user (140-146) is assigned a service class according to the grade of service guaranteed by the mobile telephone system (100) to a user (140-146) of a mobile station (120-126) on the basis of the conditions of the mobile telephone system (100).

2. A method as claimed in claim 1, **characterized** in that if the conditions of the mobile telephone system (100) allow several different service classes, the user (140-146) selects the service class that is the most economical and suitable for him.

3. A method as claimed in claim 1, **characterized** in that the present method of determining the grade of service uses as parameters preselected variables representing features of the mobile telephone system (100) and its use.

4. A method as claimed in claim 1, **characterized** in that the transmission capacity available per a user (140-146) of a mobile station (120-126) functions as the determining variable in a service class.

5. A method as claimed in claim 4, **characterized** in that the service classes are speech, data transmission, high-rate data transmission, and video.

6. A method as claimed in claim 1, **characterized** in that the transmission method used in the bidirectional radio link (130-136) changes according to the features of a service class.

7. A method as claimed in claim 6, **characterized** in that when a new user (146) tries to establish a new bidirectional radio link (136) between a new mobile station (126) and the network part (110), the new user (146) is assigned a bidirectional radio link (136) according to his service class, provided that there is a sufficient amount of transmission capacity available.

8. A method as claimed in claim 6, **characterized** in that when a new user (146) tries to establish a new bidirectional radio link (136) between a new mobile station (126) and the network part (110), the transmission capacity is checked; if the amount of available transmission

capacity is insufficient, it is checked whether some user (140-144) is underutilizing his service class, i.e. does not use the entire transmission capacity available to him; in that case the service class of the user (140-144) in question is lowered, i.e. the service class is changed to correspond to the transmission capacity utilized by the user (140-144) in question, whereby part of transmission capacity is released; this is repeated with as many users (140-144) as necessary and possible until there is a sufficient amount of transmission capacity available for the new user (146), and the new user (146) is assigned a bidirectional radio link (136) according to his service class; if there are no users (140-144) who are underutilizing their service class or their number is insufficient, the total transmission capacity of the network part (110) is in use and the new user (146) is not assigned a bidirectional radio link (136).

9. A method as claimed in claim 3, **characterized** in that the network part (110) comprises at least one network management system (260), at least one network system (210) and at least one base station system (220) comprising at least one base station controller (230) and at least one base station (240) which has a coverage area, i.e. a cell (242), the parameters of said method being the velocity of the mobile station (120) with respect to the base station (240) the load of the mobile telephone system (100) and the cell (242) type of the base station (240) providing the bidirectional radio link (130).

10. A method as claimed in claim 9, **characterized** in that the parameter of velocity is examined as the absolute velocity, the parameter of distance in proportion to the cell size of the base station (240), the parameter of load in proportion to the total capacity of the cell (242) and the parameter of cell type by employing existing hierarchical structures.

11. A method as claimed in claim 9, **characterized** in that each parameter has only a small number of different values, e.g. three.

12. A method as claimed in claim 9, **characterized** in that each parameter is given a sliding value from the minimum to the maximum.

13. A method as claimed in claim 9, **characterized** in that some parameters have only a small number of different values, e.g. three, whereas the others are given a sliding value from the minimum to the maximum.

14. A method as claimed in claim 9, **characterized** in that each service class is represented by a different state in the state machine, in

which transitions from one state to another are defined by calculation of parameters.

15. A method as claimed in claim 14, **characterized** in that the weighted average of the parameters is calculated, and it is checked which transition condition is fulfilled at any given time.

16. A method as claimed in claim 15, **characterized** in that the administrator (260) of the network part (110) of the mobile telephone system (100) defines the weighting coefficients to be used in the calculation for the parameters by means of the network management system (250).

17. A method as claimed in claim 16, **characterized** in that the calculation is carried out by the use of adaptive methods, which change the weighting coefficients to correspond to the conditions at any given time.

18. A mobile telephone system (100) comprising a network part (110), mobile station (120-126) and bidirectional radio link (130-136) between the network part (110) and mobile station (120-126), and the grade of service comprising service classes, **characterized** in that each user (140-146) is assigned a service class according to the grade of service guaranteed by the mobile telephone system (100) to a user (140-146) of a mobile station (120-126) on the basis of the conditions of the mobile telephone system (100), and in that the network part (110) is arranged to carry out the processing of parameters that is needed for assigning the service class, said parameters being preselected variables representing features of the mobile telephone system (100) and its use.

19. A system as claimed in claim 18, **characterized** in that the control unit (430) of the base station controller (230) is arranged to carry out the processing of parameters that is needed for assigning the service class.

20. A mobile telephone system (100) comprising a network part (110), mobile station (120-126) and bidirectional radio link (130-136) between the network part (110) and mobile station (120-126), the grade of service comprising service classes, **characterized** in that each user (140-146) is assigned a service class according to the grade of service guaranteed by the mobile telephone system (100) to a user (140-146) of a mobile station (120-126) on the basis of the conditions of the mobile telephone system (100), and in that the mobile station (120-126) is arranged to receive the grade of service from the network part (110).

21. A system as claimed in claim 20, **characterized** in that the mobile station (120-126) is arranged to indicate the grade of service to the user (140-146) in a clear form, e.g. as a text, picture, tone or in some other manner known from the prior art.

22. A system as claimed in claim 20 or 21, **characterized** in that more specific information is received and given to the user (140-146) on the grade of service, e.g. the transmission speed, transmission method, error correction method, charging related to the service class or other information concerning the use.

23. A system as claimed in claim 20, **characterized** in that the mobile station (120-126) is arranged to provide the user (140-146) with the possibility of selecting the grade of service that is the most economical and suitable for him.

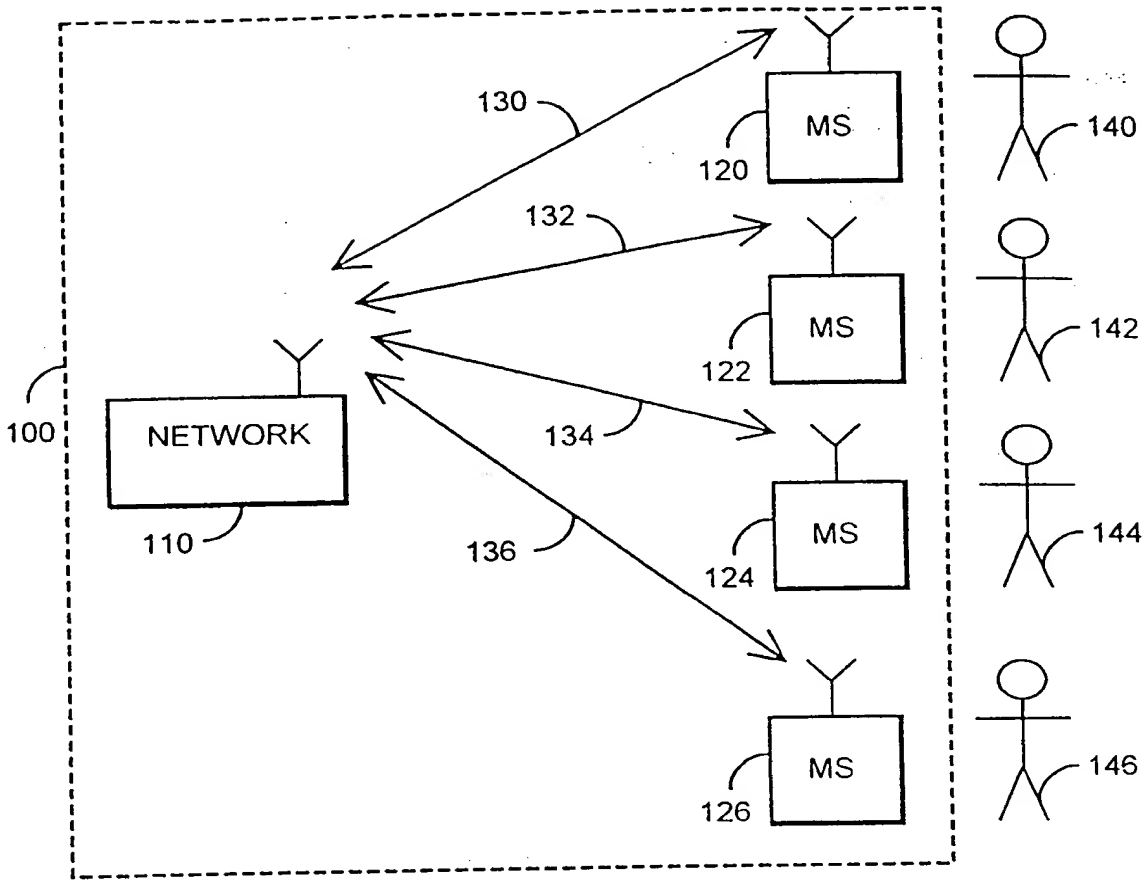
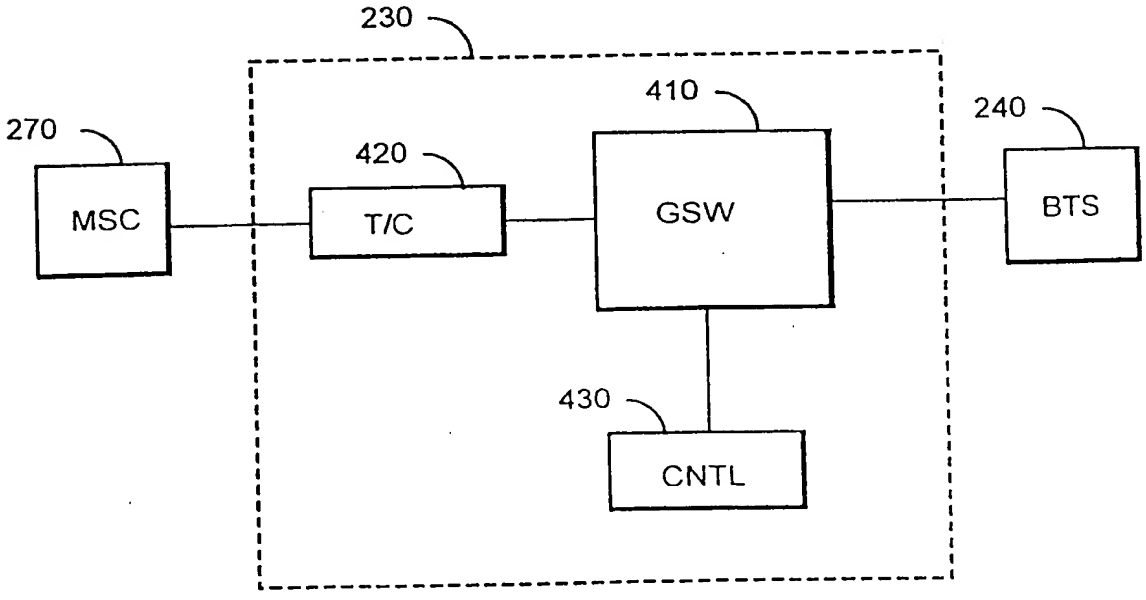

130
MS
120
140
132
MS
122
142
100
NETWORK
110
134
MS
124
144
136
MS
126
146

Fig. 1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410
270
420
240
MSC
T/C
GSW
BTS
430
CNTL

Fig. 4

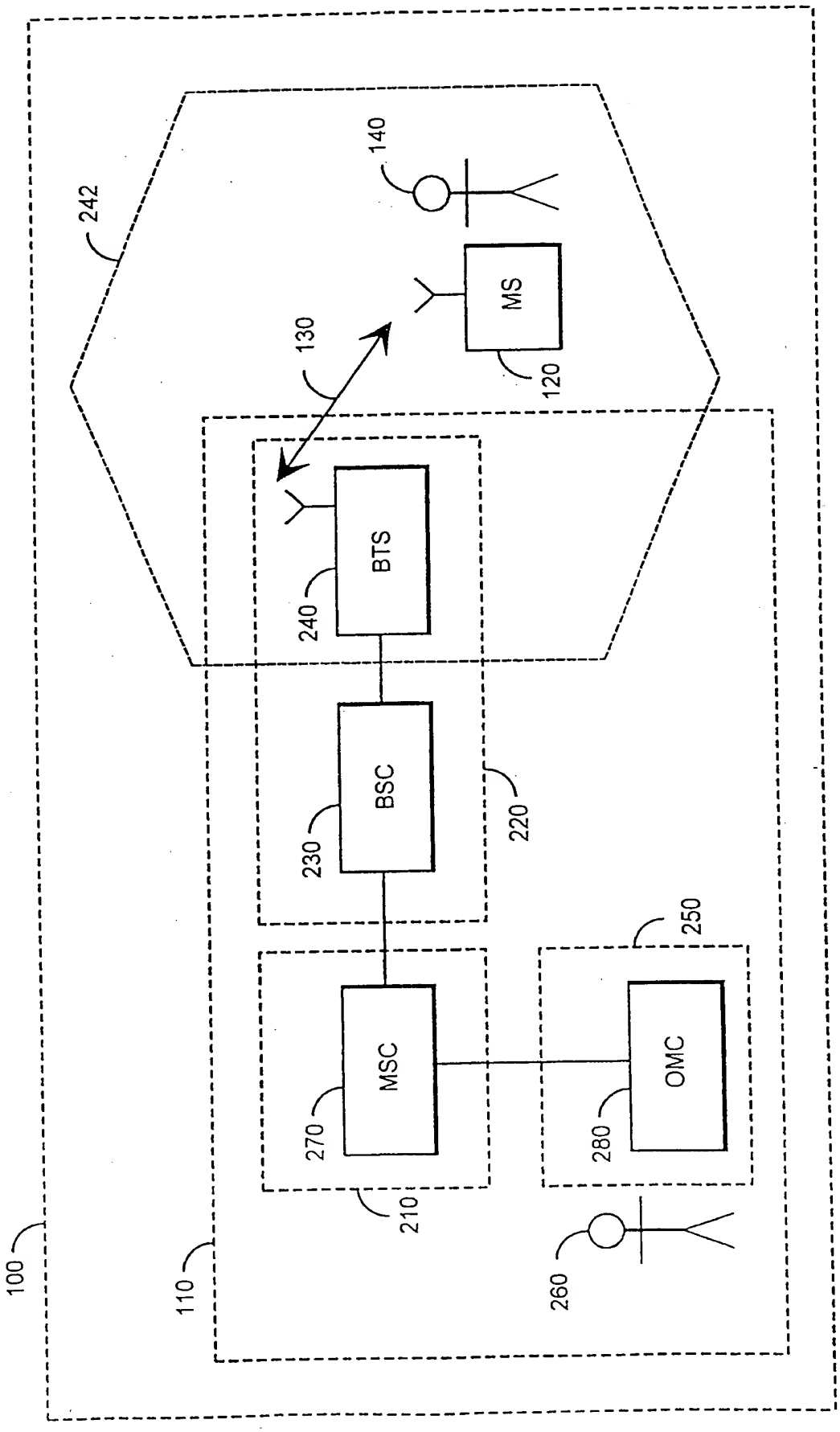
100
110
210
220
230
240
242
250
260
270
280
120
130
140
MS
BTS
BSC
MSC
OMC

Fig. 2

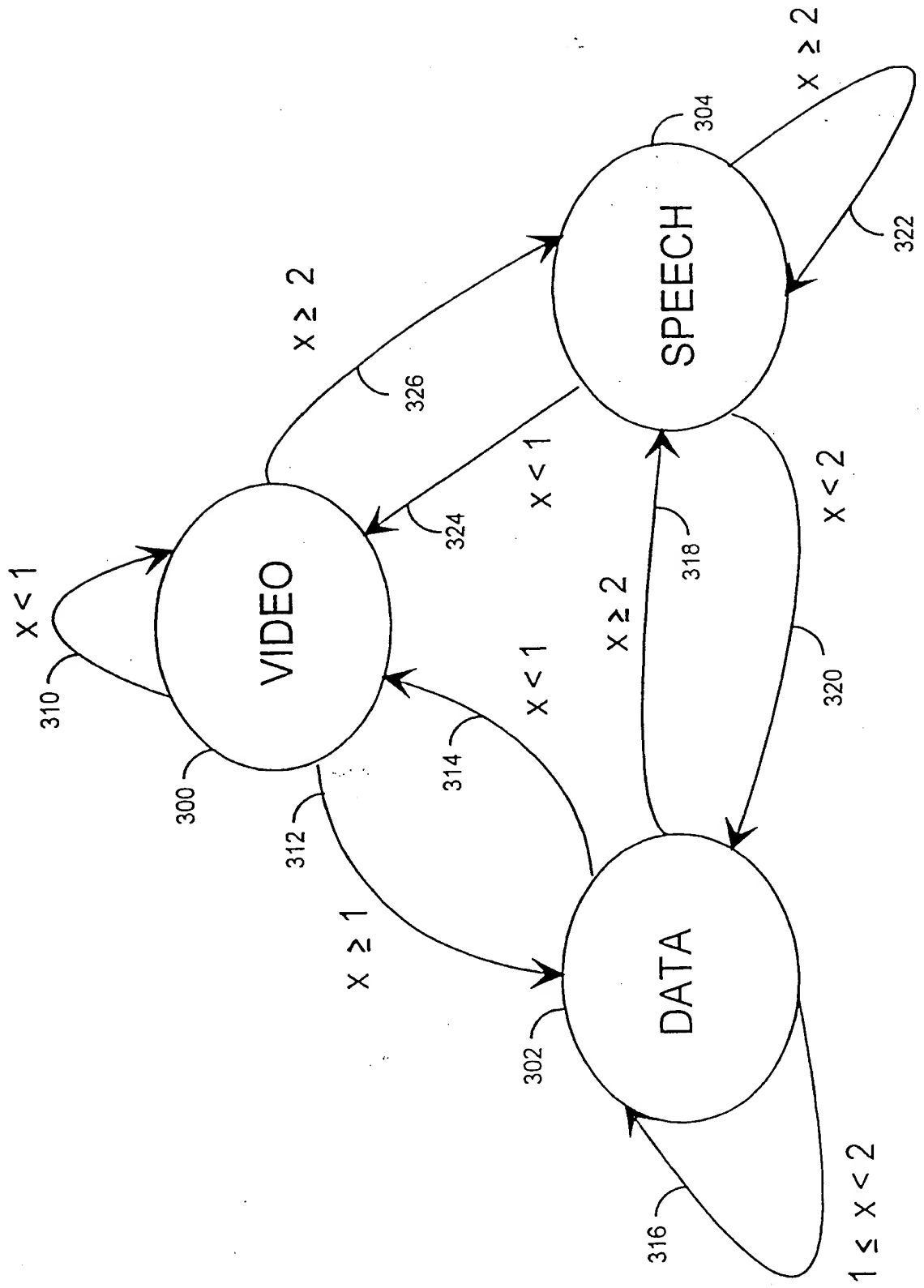
VIDEO
SPEECH
DATA
300
302
304
310
312
314
316
318
320
322
324
326
x < 1
x ≥ 1
x ≥ 2
x < 1
x ≥ 2
x < 2
x < 1
x ≥ 2
1 ≤ x < 2

Fig. 3

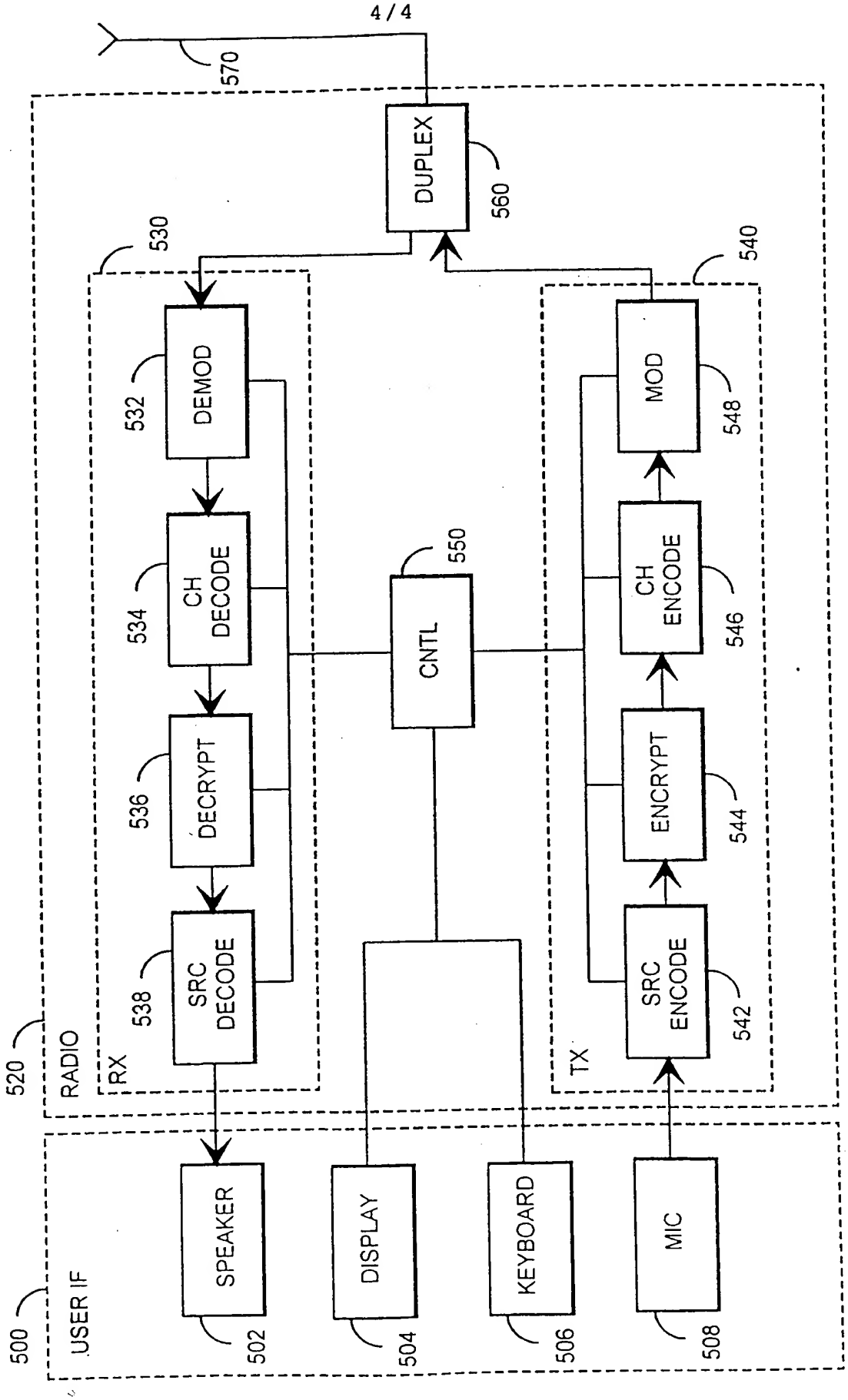
570
DUPLEX
560
530
540
DEMOD
532
MOD
548
CH DECODE
534
CH ENCODE
546
CNTL
550
DECRYPT
536
ENCRYPT
544
SRC DECODE
538
SRC ENCODE
542
520
RADIO
RX
TX
SPEAKER
502
DISPLAY
504
KEYBOARD
506
MIC
508
500
USER IF

Fig. 5

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